

NAME: Ciba Geigy
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RCRA Facility Investigation
Phase IA Report
CIBA – GEIGY Facility
Cranston, Rhode Island

Revision 1

Submitted by:

CIBA – GEIGY Corporation

444 Sawmill River Road
Ardsley, New York 10502

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RCRA FACILITY INVESTIGATION
PHASE IA REPORT
CIBA-GEIGY FACILITY
CRANSTON, RHODE ISLAND

TABLE OF CONTENTS (continued)

VOLUME 2 (continued)

- B.4 General Discussion of Geophysical Results
 - B.4.1 Production Area
 - B.4.2 Warwick Area
 - B.4.3 Waste Water Treatment Area

APPENDIX C - COMPUTER OUTPUT OF GEOPHYSICAL ANALYSES

APPENDIX D - BORING LOGS

APPENDIX E - GEOTECHNICAL LABORATORY DATA

APPENDIX F - WELL CONSTRUCTION REPORTS

APPENDIX G - SLUG TEST DATA

APPENDIX H - HEADSPACE ANALYSIS

APPENDIX I - SEISMIC REFRACTION FIELD DATA

APPENDIX J - GROUND-PENETRATING RADAR FIELD DATA

Impact of Phase IA

As a result of the findings from the four Phase IA investigations:

- o no major changes to the RFI Work Plan will be required; and
- o no work will be deleted from the Work Plan; but
- o some additional work will be required to characterize the site stratigraphy and ground water hydraulics further.

Data Collected but Not Used in This Report

Some supplementary physicochemical data collection occurred during Phase IA as an adjunct to the investigations. These supplementary data from Phase IA will be carried forward and compared with data collected in Phase IB. These supplementary data include:

- o headspace analysis (field screening) of soil samples;
- o cation exchange capacity, total organic carbon, and pH of soil and sediment samples; and
- o collection of undisturbed samples for hydraulic conductivity, bulk density, porosity, and grain size.

Although not specifically part of the Physical Characterization, the results of the headspace analysis suggested one minor change in the Phase IB Work Plan:

- o Soil samples from a new boring near P-21D will be analyzed for Appendix IX volatile organic compounds in order to investigate further the anomalous headspace results detected in samples from P-21D.

This change to the Work Plan is discussed in Section 6.4 of this Report.

Limitations of the Phase IA Geotechnical Data

As part of the Phase IA investigation, soil and riverbed sediment samples were obtained and submitted for geotechnical analyses (e.g., grain size, porosity, bulk density, and hydraulic conductivity). Although the geotechnical data from those analyses are reported in this document, the samples were not analyzed according to the procedures described in the project QA/QC Plan. Specific nonconformances included:

- o validation (through reasonableness) of results were not performed by the laboratory for all samples;
- o grain size analyses were not performed for all samples according to the ASTM sieves procedures specified in the QA/QC Plan; and,
- o undisturbed soil samples (P22D-ST1 and P22D-ST2) were re-molded prior to analysis.

Because of these departures from the approved QA/QC procedures, the geotechnical data are suspect. These suspect data created data gaps in the Phase IA investigation; these data gaps will be resolved in Phase IB. Specific corrective action includes the choice of a new laboratory capable of performing the detailed scope of work.

Organization of this Executive Summary

The rest of this executive summary provides additional details about the geophysical, geological, hydrogeological, and hydrological investigations conducted in Phase IA. Each investigation is described briefly by addressing these topics:

- o the purposes of the investigation;
- o the results of the investigation; and
- o the impact of the investigation on the Phase IB Work Plan (if any).

conductivities of the stratigraphic units. Data from the hydrogeological investigation will be used to select monitoring well locations for the Release Characterization Program (i.e., Phase IB).

The methods and analyses used in performing the three tasks in the hydrogeological investigation are described in detail in Section 4.3 of the Report.

Results of the Hydrogeological Investigation

The hydrogeological investigation provided the following information:

- o The bedrock aquifer appears to be confined, but the direction of ground water flow could not be determined.
- o There are significant upward potential gradients within the overburden.
- o The apparent gradients (between wells in the same zone) were determined:
 - bedrock aquifer: 0.003 to 0.005;
 - deep overburden aquifer: 0.02 to 0.1; and
 - shallow overburden aquifer: 0.013 to 0.1.

The results obtained from the hydrogeological investigation are described in Section 4.4 and discussed in Section 4.5 of this Report.

Impact of the Hydrogeological Investigation

The hydrogeological investigation revealed data gaps that require additional work (not included in the RFI Work Plan) and also suggested changes to the Phase IB Work Plan. No work will be deleted from the Work Plan.

The hydrogeological investigation revealed the following data gaps which must be addressed by additional work:

- o The ground water flow patterns, hydraulic gradients, and formation permeabilities of the underlying strata must be characterized better. To do so, new stratigraphic borings (off-site) will be completed as deep piezometers. Shallow monitoring wells will also be installed to evaluate background water quality at these locations. On-site stratigraphic borings will also be completed as deep piezometers. A shallow piezometer will also be installed to establish a nested piezometer pair at one boring location.
- o The site hydraulics must be evaluated better. To do so, the following tasks will be performed:
 - In Phase IB, all existing monitoring wells and piezometers will be rehabilitated, as appropriate.
 - Water level measurements will be taken monthly, not quarterly.
 - Long-term automatic ground water level data logging will be performed in a few selected wells in the Production Area.
 - Small scale (i.e., short-duration, low rate) step drawdown tests will be performed in the Production Area.
 - Short-term constant rate pump tests will be performed on selected wells in the Production Area. The rate and duration for the tests will be determined based on the results of the step drawdown tests.

These recommendations for additional work are described in Section 6.4 of this Report.

The results of the hydrogeological investigation also suggested changes in the Phase IB Work Plan:

- o The locations of MW-10S and MW-10D (Figure 6-2) will be shifted slightly east to be downgradient of SWMU-2, based on our current (9/13/90) water table contour map (Figure 4-5).

Each seismic line consisted of 12 Mark Products geophones generally positioned at 20-foot intervals. Some geophones were spaced closer together or farther apart to allow for obstructions (trees, brush, etc.). The geophones were connected by cable to a 12-channel EG&G Nimbus Signal Enhancement Seismograph which produced a hard-copy printout of the travel times to each geophone.

The survey used eleven seismic refraction lines to provide a continuous profile of subsurface geological units and the top of the underlying bedrock. The first seven lines were completed in October 1989; the other four lines were run in July 1990. Three seismic refraction lines were run in the Production Area, five were run in the Warwick Area, and three were run in the Waste Water Treatment Area. Figure 2-1 shows the location of each line. The seismic refraction survey field data are presented in Appendix I.

Analyses

The travel time data and time-distance plots for each seismic line, along with the elevations of all geophones and shots, were entered into the SIPT2 computer program (written by the U.S. Bureau of Mines). The computer program determined the velocity of each refracting layer using time-distance calculations and other procedures developed by Hobson (1966). Depths and thicknesses of identified refracting layers were derived using standard travel time analysis methods. The methods were refined, where possible, by iterative ray-tracing techniques (Scott, 1972; Yacoub, 1970). The results were presented as cross-sections depicting the depths of the refracting layer(s) beneath each line. Geological data from borehole sampling were compared to the cross-sections to aid in data interpretation. (These comparisons are discussed in Section 3.0.)

coupled with, the ground surface. The transmitting antenna is towed along the ground at a constant speed, and a 0.5 milliwatt signal pulse is radiated downward at a repetition rate of 50 kilohertz (Khz). The reflected signal is picked up by a receiving antenna. The reflected signals are amplified and processed, and subsequently printed on a high-speed scanning graphic recorder to permit observation and interpretation of the subsurface in real time. Travel times of the reflected pulses can be converted to depths from which the pulses were reflected. By towing the transmitting antenna over the traverses (lines) of a rectangular grid, the size and orientation of the reflective subsurface features can be estimated.

This survey used a Geophysical Survey Systems SIR System 8 unit, which produced a continuous graphical record of the subsurface along each traverse on a high-speed graphic line scan recorder. The system was set to record reflections from travel times corresponding to depths of 0 to 10 feet. The transmitting antenna was towed behind a pickup truck when possible, but was pulled by hand in areas where the vehicle would have been unable to turn around. The GPR survey used three grids with lines running north-south and east-west. The Production Area was surveyed in a ten-foot grid. The Warwick and Waste Water Treatment areas were surveyed in twenty-foot grids. The grid survey work was performed by a licensed (subcontract) surveyor. Each of the three grids was tied into the Rhode Island survey grid by at least one point. Figures 2-2, 2-3, and 2-4 show the grids, starting points, and directions of traversal for the GPR surveys in the Production, Warwick, and Waste Water Treatment areas, respectively. The GPR survey field data are presented in Appendix J at a 50% reduction from actual size.

Analyses

The GPR data were interpreted and subsurface anomalies were identified and plotted on a map of each study area in two dimensions (depth and width of feature) for each transect. The third dimension (length of feature) was added by

Results of the ground-penetrating radar survey (Figure 2-10) indicate that individual buried utilities could not be discriminated in this area. The numerous pipe-like anomalies that were located do not match the pipe locations shown on the utility maps. Slab-like anomalies generally agreed with foundations shown on the utility maps.

The pipe-like anomalies found in the ground-penetrating radar survey may be pipes or other metal conduits associated with former manufacturing in this area, or they may be remnants of metallic debris mixed in with the fill when the buildings were razed (e.g., reinforcing bars or pipe sections). Although an attempt was made to tie the anomalies together across grid lines (Figure 2-10), the reconnaissance-level grid scales used in this survey (ten to twenty feet) do not allow the anomalies to be traced reliably to discern their true nature.

The slab-like anomalies found in the ground-penetrating radar survey (Figure 2-6) may be local impediments to precipitation infiltration, but should not impede ground water flow in the near surface because they generally lie entirely above the water table (determined from the other geophysical surveys and in the soil borings to range from depths of 3 to 18 feet).

2.4.2 Warwick Area

Results of the five seismic refraction lines run in the Warwick Area (Figures 2-11 through 2-15) indicate that bedrock lies at an average depth of 55 to 60 feet. Bedrock may be overlain by a dense glacial till of varying thickness. Alluvium consisting of interbedded and discontinuous sands, clays, silts, and gravels extends from the ground surface to the till.

Results of the five electrical resistivity soundings run in the Warwick Area (Figures 2-16 through 2-20) generally agree with the results of the seismic refraction

survey. Bedrock appears to lie at depths of about 60 feet, and is overlain by a dense glacial till of varying thickness (up to about 30 feet thick). Interfingering and discontinuous alluvium consisting of sands, silts, clays, and gravels extends from the surface to the till.

Results of the ground-penetrating radar survey (Figure 2-21) indicate that individual buried utilities could not be discriminated in this area. The pipe-like anomalies that were located do not match the pipe locations shown on the utility maps. Slab-like anomalies generally agreed with foundations shown on the utility maps.

The pipe-like anomalies found in the ground-penetrating radar survey may be pipes or other metal conduits associated with former manufacturing in this area, or they may be remnants of metallic debris mixed in with the fill when the buildings were razed (e.g., reinforcing bars or pipe sections). Although an attempt was made to tie the anomalies together across grid lines (Figure 2-21), the reconnaissance-level grid scales used in this survey (ten to twenty feet) do not allow the anomalies to be traced reliably to discern their true nature.

The slab-like anomalies found in the ground-penetrating radar survey (Figure 2-21) may be local impediments to precipitation infiltration, but should not impede ground water flow in the near surface because they generally lie entirely above the water table (determined from the other geophysical surveys and in the soil borings to range from depths of 3 to 18 feet).

2.4.3 Waste Water Treatment Area

Results of the three seismic refraction lines run in the Waste Water Treatment Area (Figures 2-22 through 2-24) indicate that bedrock (layer 3) lies at depths of about 45 to 60 feet. Results generally indicate that a dense glacial till of varying thickness lies at depths ranging from about 25 to 50 feet. Alluvium overlies the till and consists of interbedded and discontinuous sands, clays, and gravels.

Results of the three electrical resistivity soundings run in the Waste Water Treatment Area (Figures 2-25 through 2-27) generally agree with the results of the seismic refraction survey, and indicate bedrock lying at depths of about 45 to 60 feet. Glacial till of varying thickness (10 to 30 feet thick) overlies the bedrock. Discontinuous and interfingering alluvium consisting of sands, clayey silts, silty clays, and gravels overlies the till.

Results of the ground-penetrating radar survey (Figure 2-28) indicate that individual buried utilities could not be discriminated in this area. The pipe-like anomalies that were located do not match the pipe locations shown on the utility maps. Slab-like anomalies generally agreed with foundations shown on the utility maps.

The pipe-like anomalies found in the ground-penetrating radar survey may be pipes or other metal conduits associated with former manufacturing in this area, or they may be remnants of metallic debris mixed in with the fill when the buildings were razed (e.g., reinforcing bars or pipe sections). Although an attempt was made to tie the anomalies together across grid lines (Figure 2-28), the reconnaissance-level grid scales used in this survey (ten to twenty feet) do not allow the anomalies to be traced reliably to discern their true nature.

The slab-like anomalies found in the ground-penetrating radar survey (Figure 2-28) may be local impediments to precipitation infiltration, but should not

impede ground water flow in the near surface because they generally lie entirely above the water table (determined from the other geophysical surveys and in the soil borings to range from depths of 3 to 18 feet).

2.5 DISCUSSION

This section compares the results obtained from the seismic refraction and electrical resistivity surveys in the Production, Warwick, and Waste Water Treatment areas. Since the ground-penetrating radar survey only extended to a depth of 10 feet and no correlations could be made with mapped utilities, it will not be discussed further.

- o Production Area -- 10-15 feet;
 - o Water Treatment Area -- 10-30 feet; and
 - o Warwick Area -- 20-30 feet.
5. The overburden deposits, which consisted of fine sands, silts, clays, and some gravels, were characterized by gradational facies changes in both the vertical and horizontal dimensions.
 6. Ground-penetrating radar (GPR) was not successful in discriminating subsurface utilities at the site. Slab-like anomalies found in the GPR surveys generally lie above the water table, and do not appear to impede ground water flow in the near-surface.
 7. Electrical resistivity was a more effective method than seismic refraction in differentiating bedrock, till, and individual units of the overburden deposits.

Geological Results. The following conclusions were drawn from the results of the geological investigation:

1. Bedrock beneath the facility consists of partially metamorphosed sandstones and shales, consistent with lithologies of the Rhode Island Formation.
2. Till was encountered in several borings.
3. The variable nature of the overburden deposits is consistent with a glaciofluvial and/or fluvial deposition.
4. The overburden deposits are more complex than anticipated based on the Phase IA results and on previous data. Individual units appear to be discontinuous both vertically and horizontally.

5. Good correlations were made between the boring data and the electrical resistivity data.
6. Till and bedrock have similar seismic velocities and cannot be distinguished reliably by the seismic refraction method. Higher-density deposits overlie lower density deposits. Hence, the seismic refraction method is not the geophysical method of choice for differentiating the overburden soils, till, and bedrock at the site.

Hydrogeological Results. The following conclusions were drawn from the results of the hydrogeological investigation:

1. In the bedrock aquifer, there is a net upward potential gradient at three locations and a downward potential gradient at one location.
2. There are significant upward potential gradients within the overburden.
3. The apparent gradients (between wells in the same zone) were determined:
 - o bedrock aquifer -- .003 to .005;
 - o deep overburden aquifer -- .02 to .1; and
 - o shallow overburden aquifer -- .013 to .1.

Hydrological Results. The following conclusions were drawn from the results of the hydrological investigation:

1. Discharge values calculated from the three discharge monitoring events fall within the 30th and 70th percentile range of the discharge frequency statistic reported for the USGS gauge at Cranston, Rhode Island.
2. Working rating curves were developed for the transects at this site.

3. Relatively low concentrations of suspended sediment were detected at both the DSD and DSU transects at all three observed flow conditions.
4. Bed sediment is primarily sands and gravels except along the bulkhead where samples were finer-grained.
5. No bedforms having amplitudes greater than six inches were observed.
6. The Froude number calculated for the maximum flow rate observed indicates that the observed river conditions are within the lower flow regime. Therefore, bedload sediment transport rates appear to be low under the conditions observed. The monitoring events did not include flood conditions.

6.3 IMPACT OF PHASE IA

Sampling locations for the Phase IB investigation are presented in Figures 6-1 and 6-2. Details of the Phase IB investigation are presented in the RFI Work Plan (Volume 1, Chapter 3, Section 4). The Phase IA results suggest the following impacts on the Phase IB investigation:

- o No major modifications to the sampling strategy proposed for the release characterization (Phase IB) are required.
- o The locations of MW-10S and MW-10D (Figure 6-2) will be shifted east to be downgradient of SWMU-2, based on our current (13 September 1990) water table contour map (Figure 4-5).
- o Screen settings also will be modified based on our current understanding of site stratigraphy and on boring data.

- o Anomalous headspace results were detected in soil samples from boring P-21D. Because these hits could not be attributed to known past facility releases or methane interferences, soil samples from a boring near P-21D will be analyzed for Appendix IX volatile organic compounds.

6.4 RECOMMENDATIONS FOR FURTHER WORK

Review and evaluation of the Phase IA results identified new data gaps. Additional characterization studies are recommended to provide a better understanding of the facility's physical environment. Recommendations for additional work (not included in the RFI Work Plan) are presented here.

Geological Needs

- o Three additional continuous sample borings will be advanced to define better the facility's stratigraphy in more detail. One boring (B-19A) will be located in the northwest corner of the Waste Water Treatment Area; the other borings (B-20 and B-21) will be located in the western section of the Warwick Area (as shown in Figure 6.1).
- o Off-site, two additional borings (B-17A and B-18A) will be advanced to help evaluate the hydrostratigraphic conditions at the facility. The borings will be located north and west of the Waste Water Treatment Area (as shown in Figure 6.1).
- o Soil samples from borings will be tested in the laboratory to differentiate between fine-grained (silts) and very fine-grained (clay) materials. Every other soil sample from borings advanced in Phase IB will be analyzed for grain size.

Wells will be determined after Phase IB monitoring wells are installed and the first sampling is completed.

Hydrological Needs

- o All surface water samples collected from the Pawtuxet River during Phase IB will be analyzed for total suspended solids (TSS). Addition of this analyte will enable integration of chemical analytical results with the suspended sediment characteristics of the water samples.

Analytical Needs

- o Soil samples from a boring near P-21D will be analyzed for Appendix IX volatile organic compounds (based on anomalous headspace results from soil samples collected from P-21B).

6.5 SUMMARY

This section presented the conclusions from the Phase IA investigation, the impact on the Phase IB investigation, and recommendations for additional work. Overall, no major modifications to the Phase IB investigation are required, but a number of minor modifications for additional work are recommended.

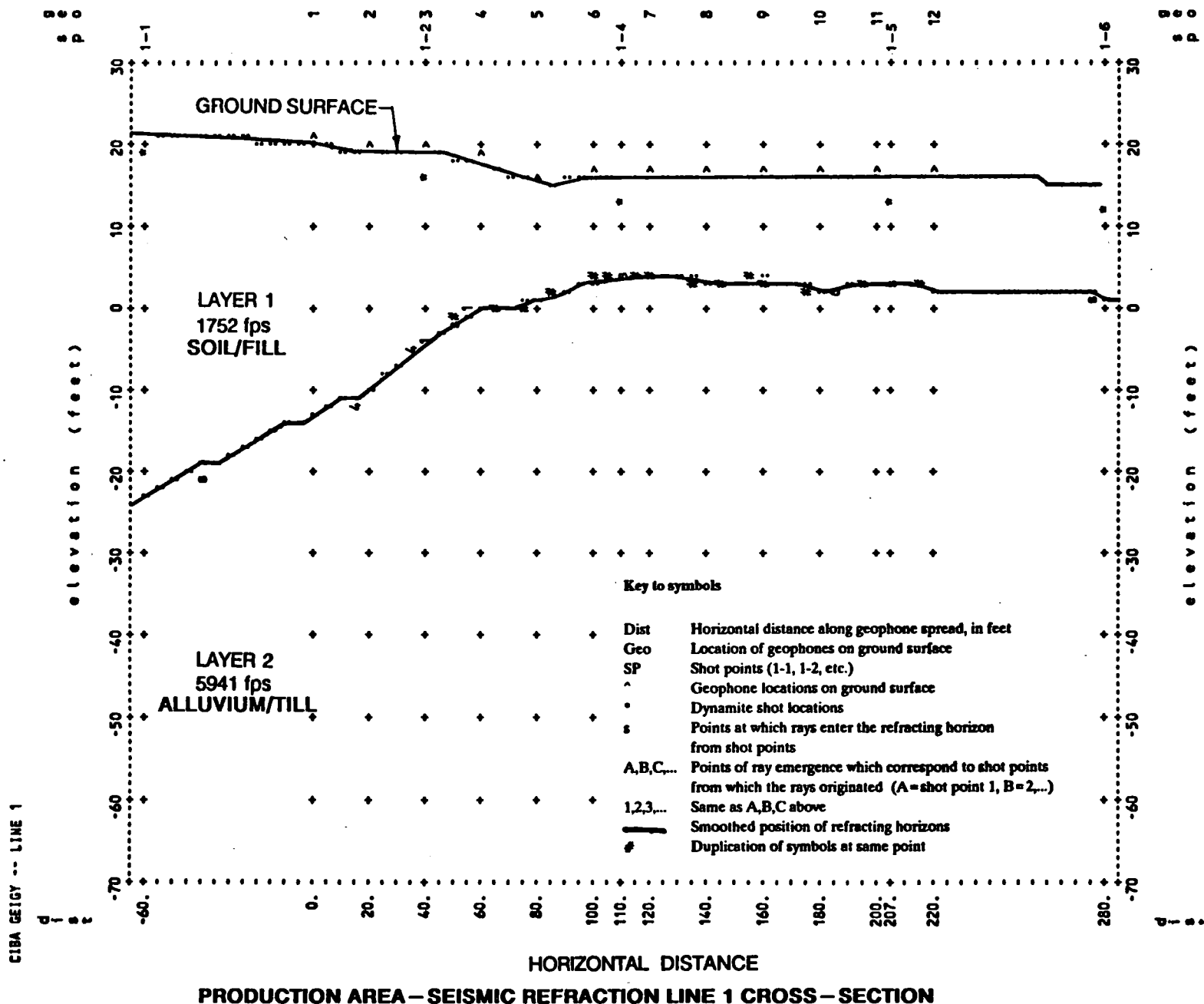
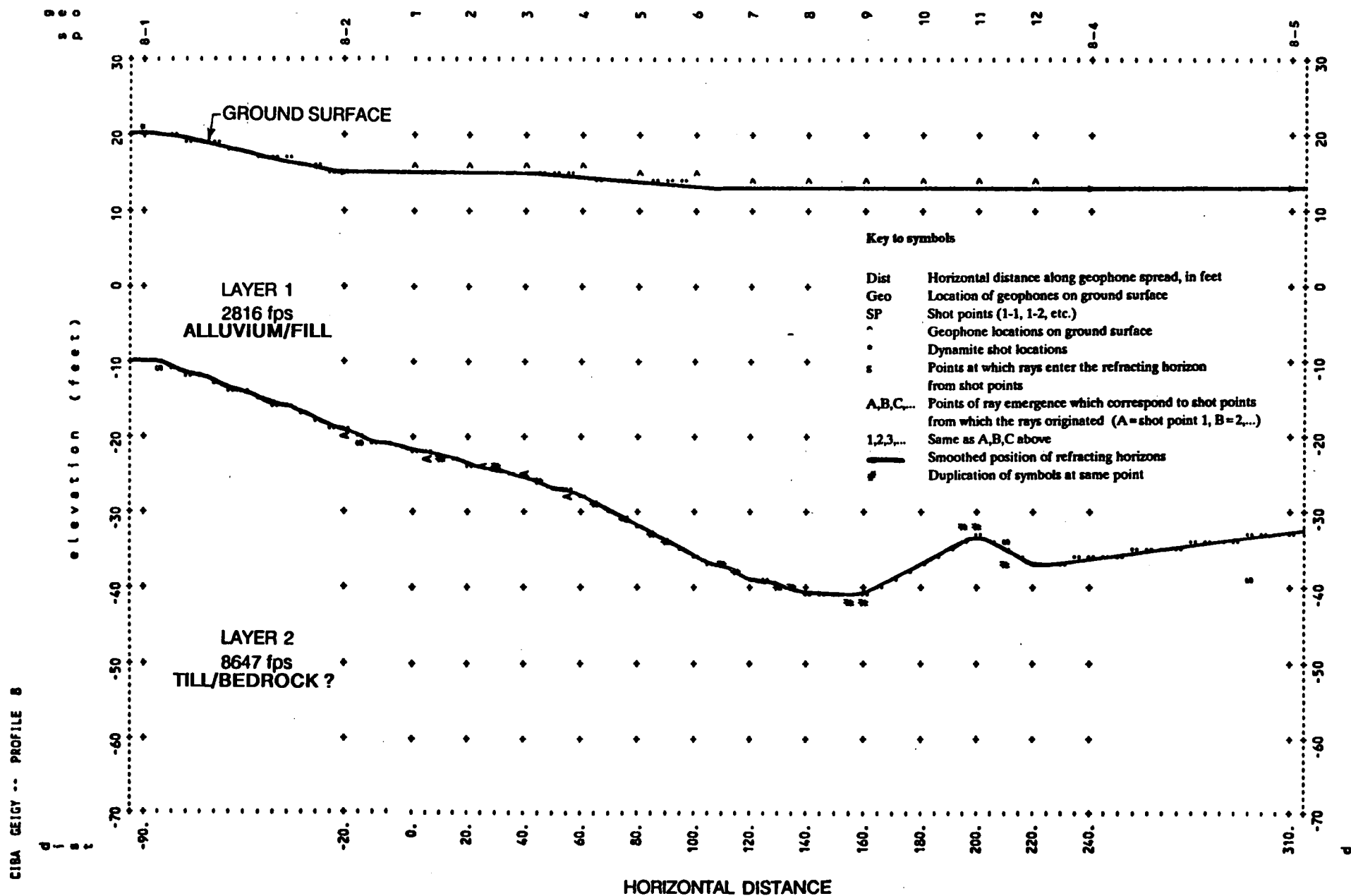
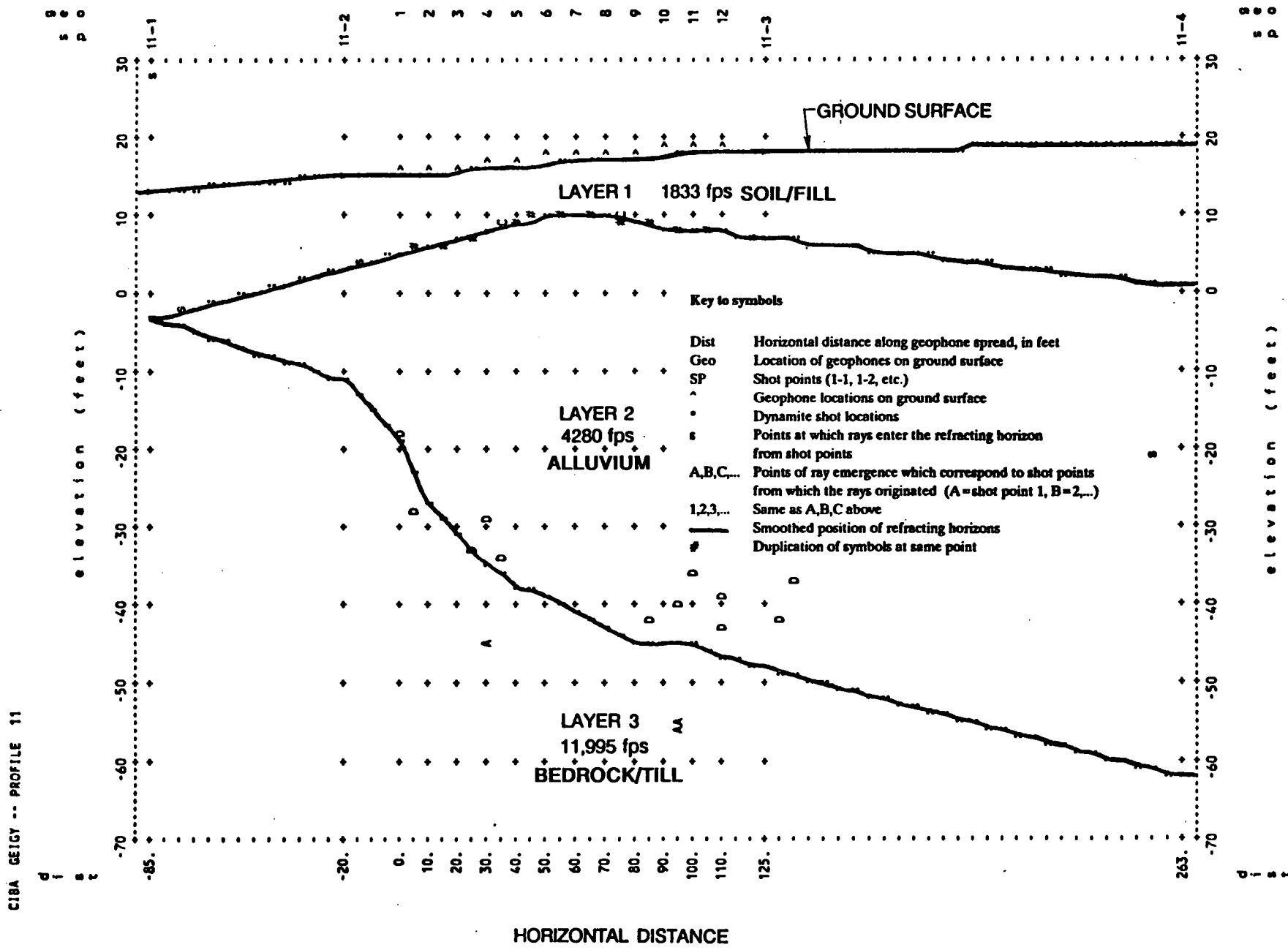


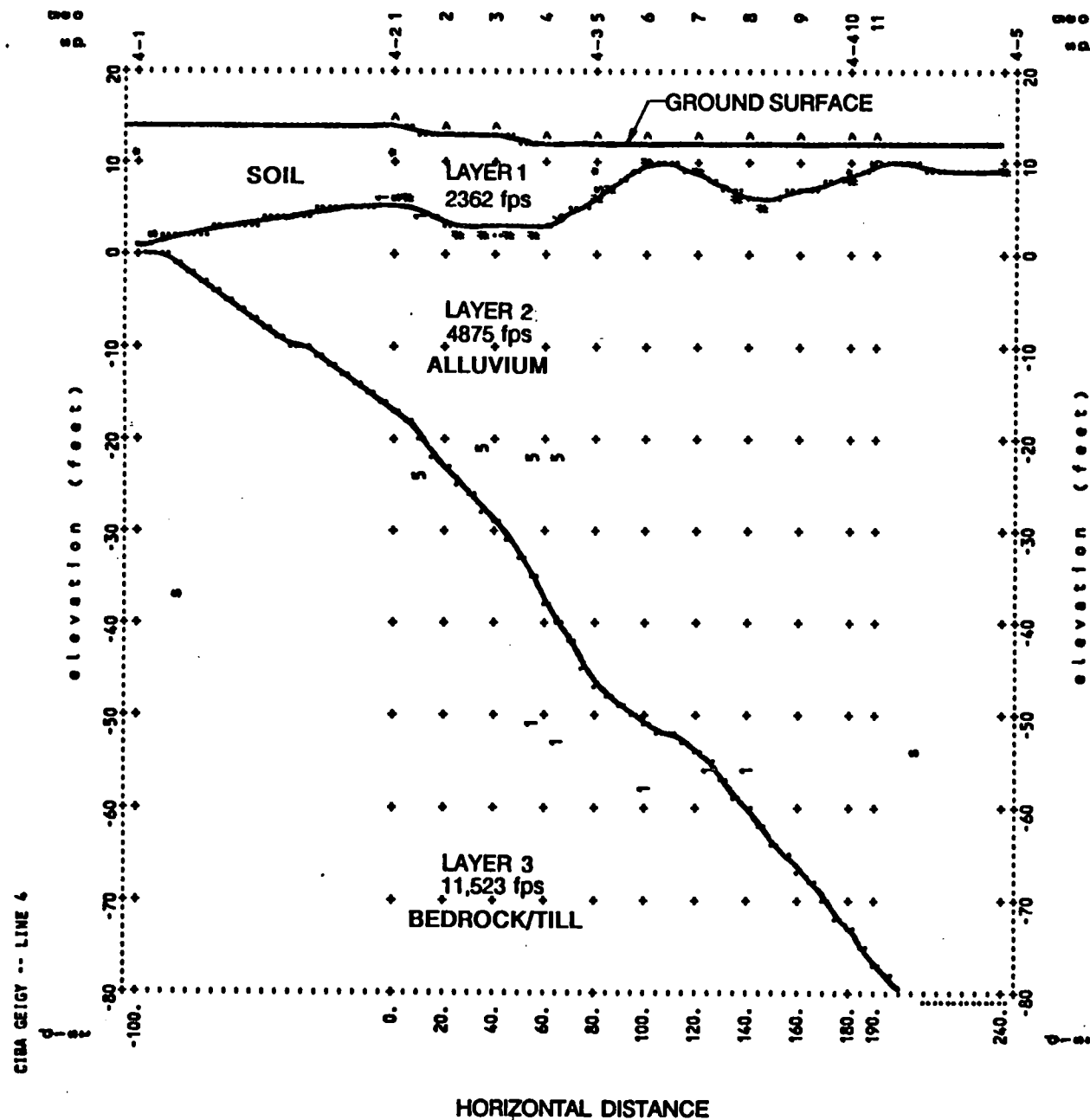
FIGURE 2-5



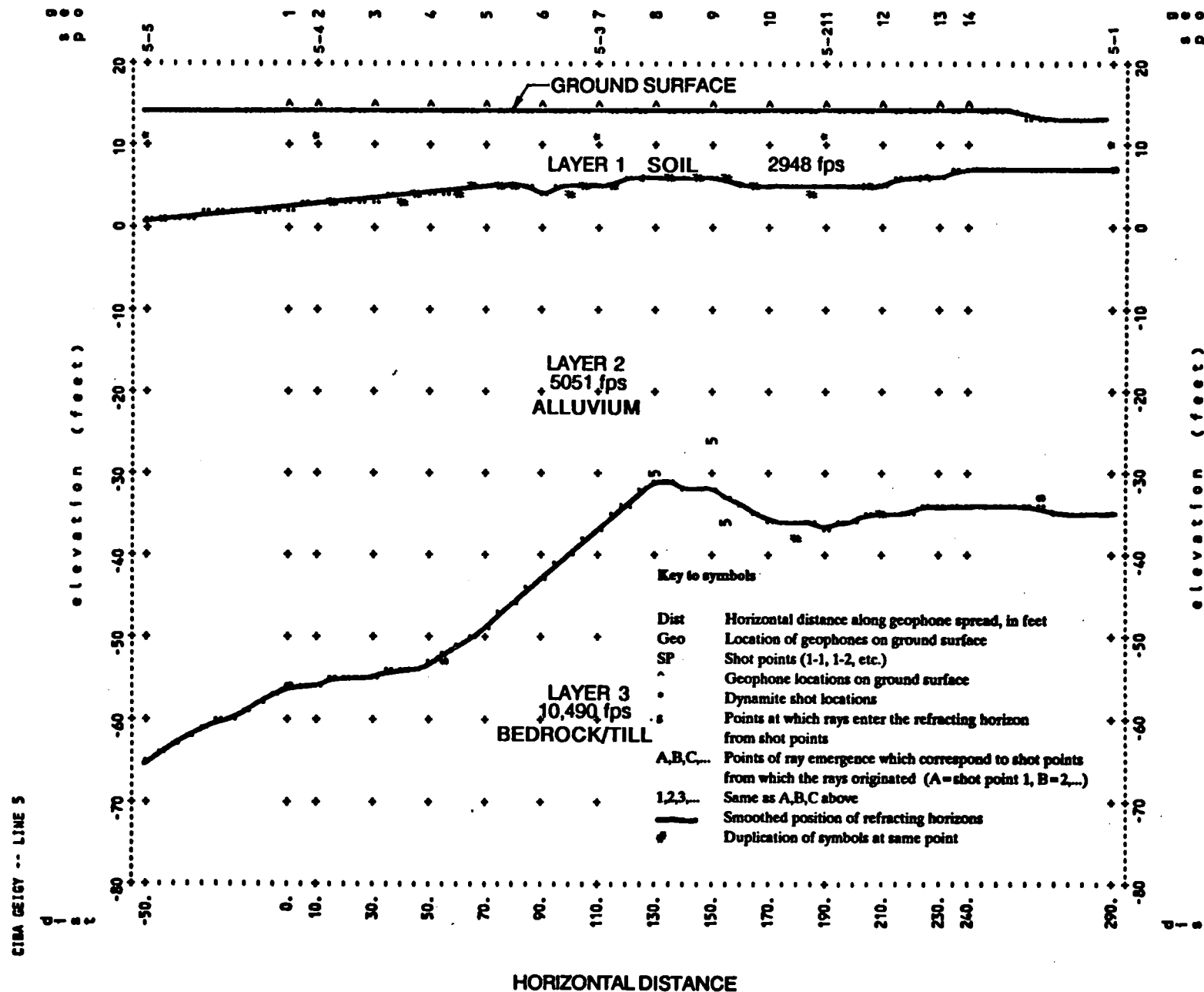
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PRODUCTION AREA—SEISMIC REFRACTION LINE 11 CROSS—SECTION

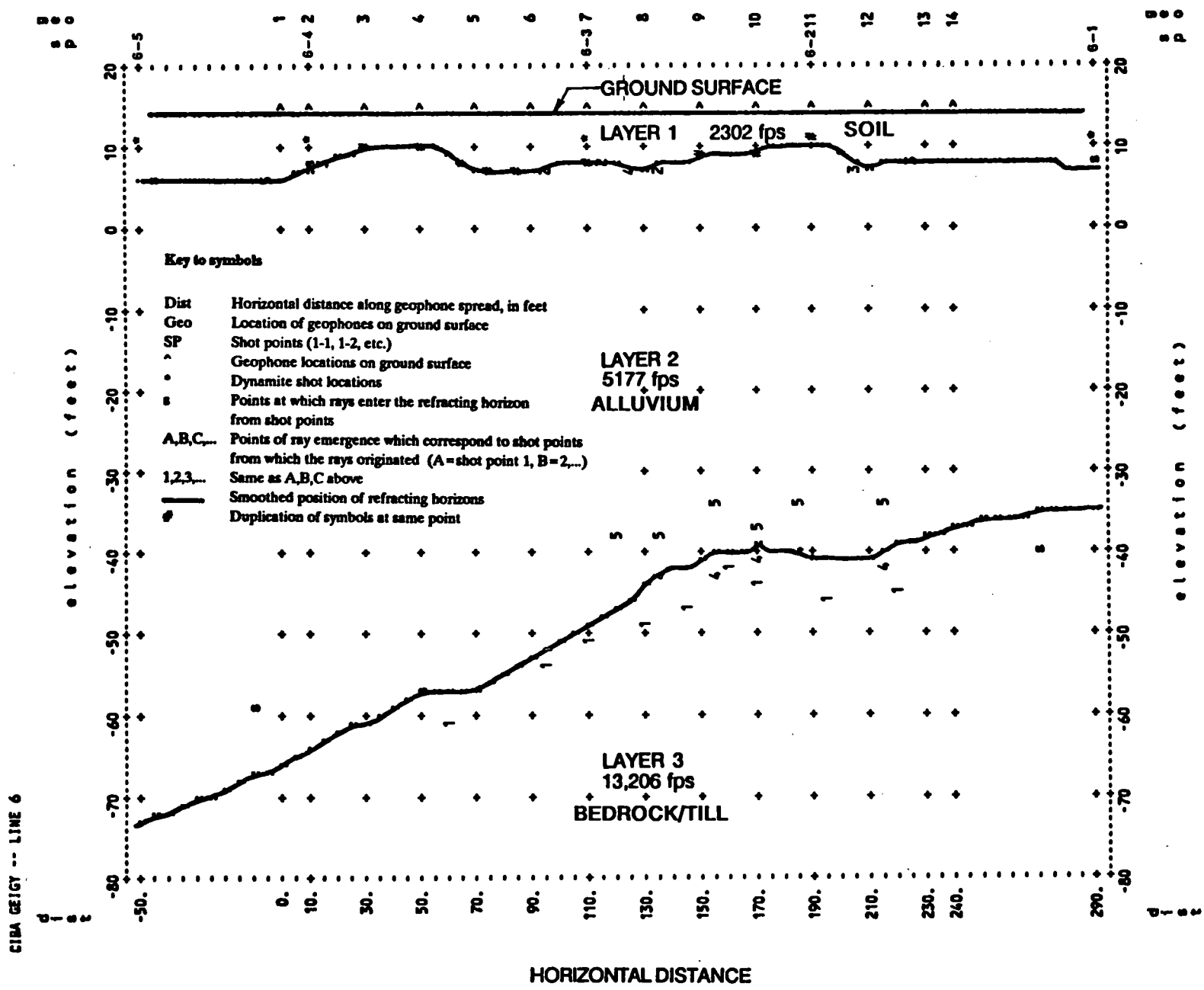


WARWICK AREA — SEISMIC REFRACTION LINE 4 CROSS — SECTION



WARWICK AREA—SEISMIC REFRACTION LINE 5 CROSS—SECTION

FIGURE 2—12



WARWICK AREA — SEISMIC REFRACTION LINE 6 CROSS — SECTION

FIGURE 2 — 13

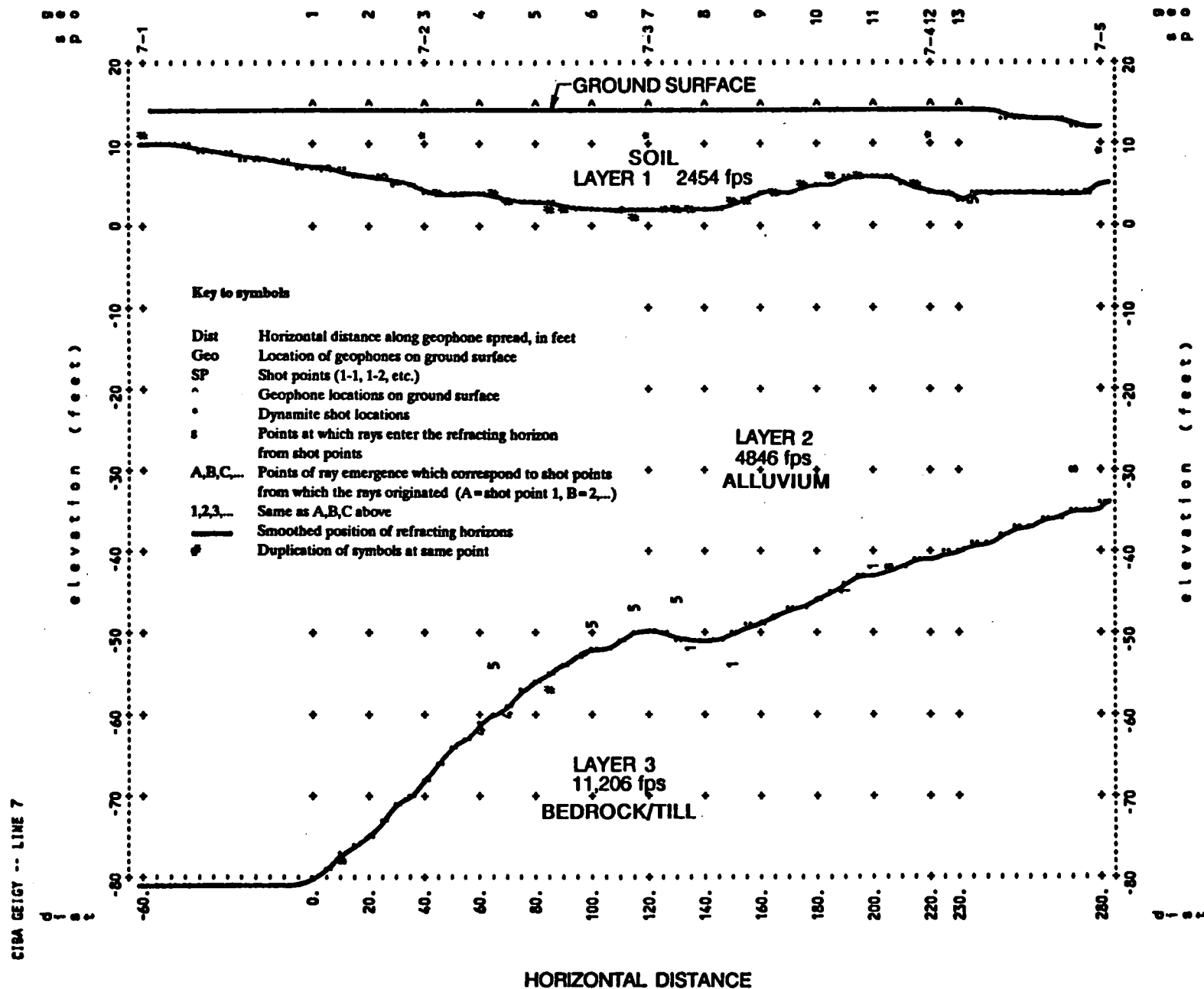
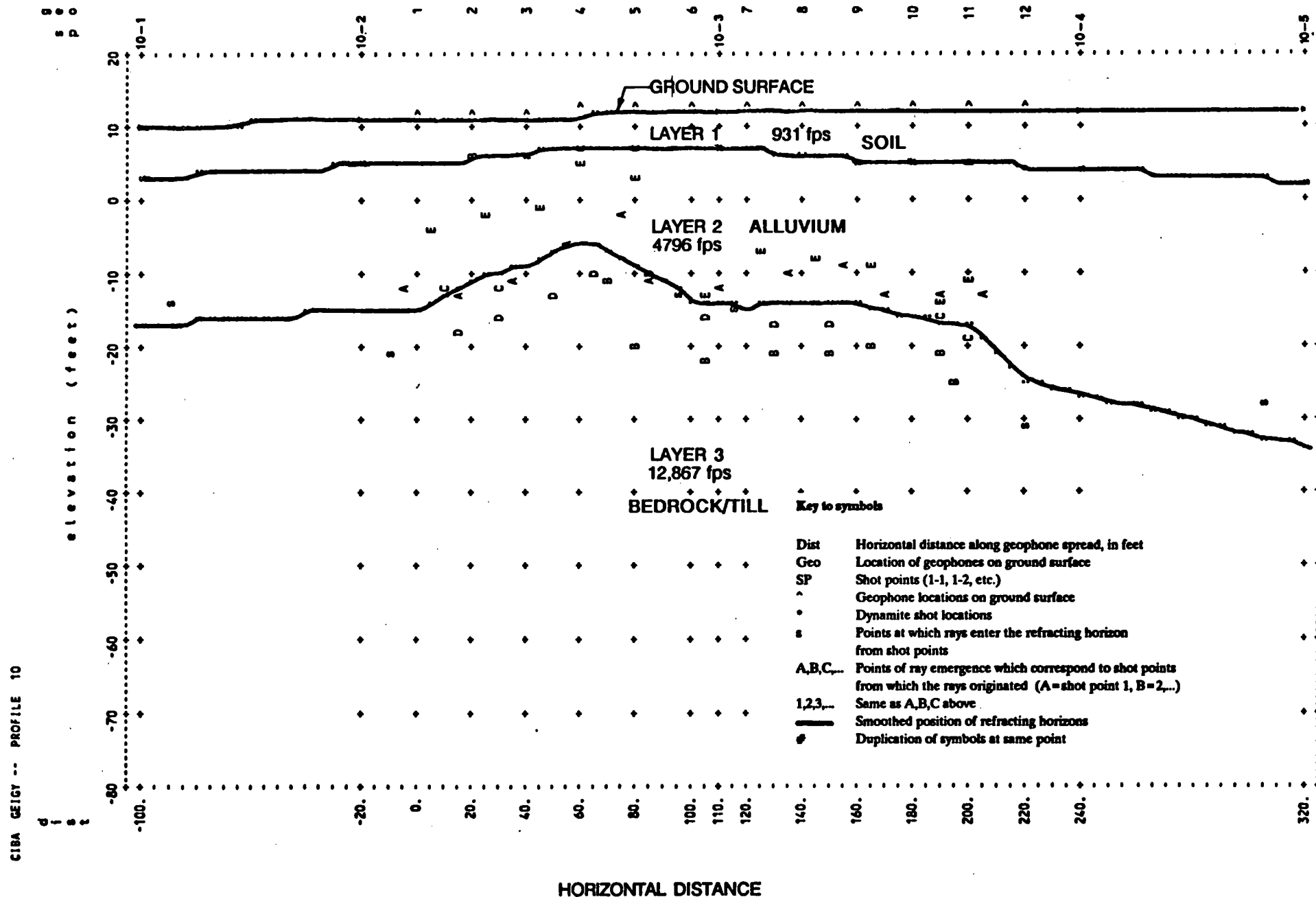
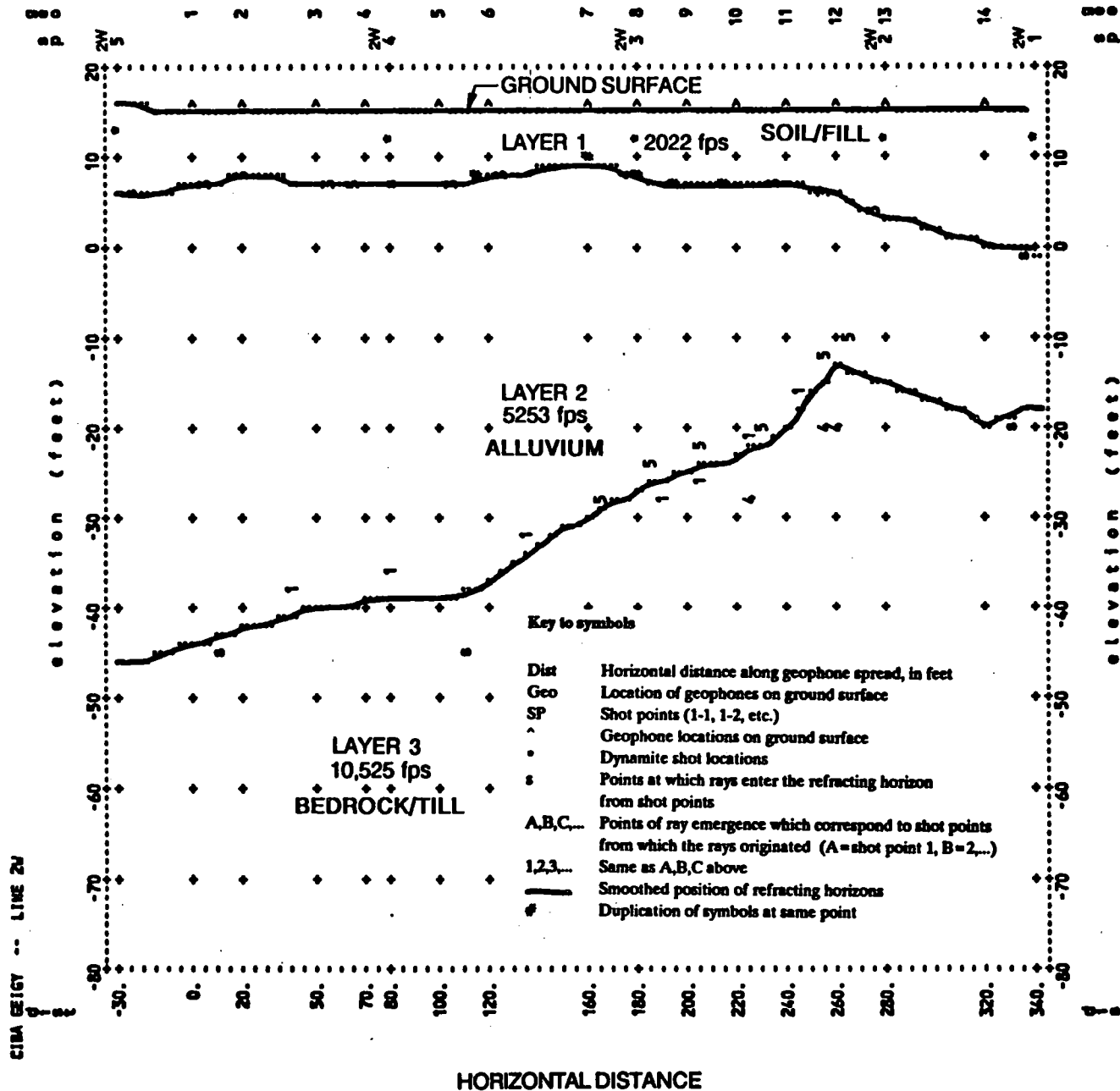


FIGURE 2-14



WARWICK AREA — SEISMIC REFRACTION LINE 10 CROSS — SECTION

FIGURE 2 — 15



WASTE WATER TREATMENT AREA — SEISMIC REFRACTION LINE 2W CROSS-SECTION

FIGURE 2-22

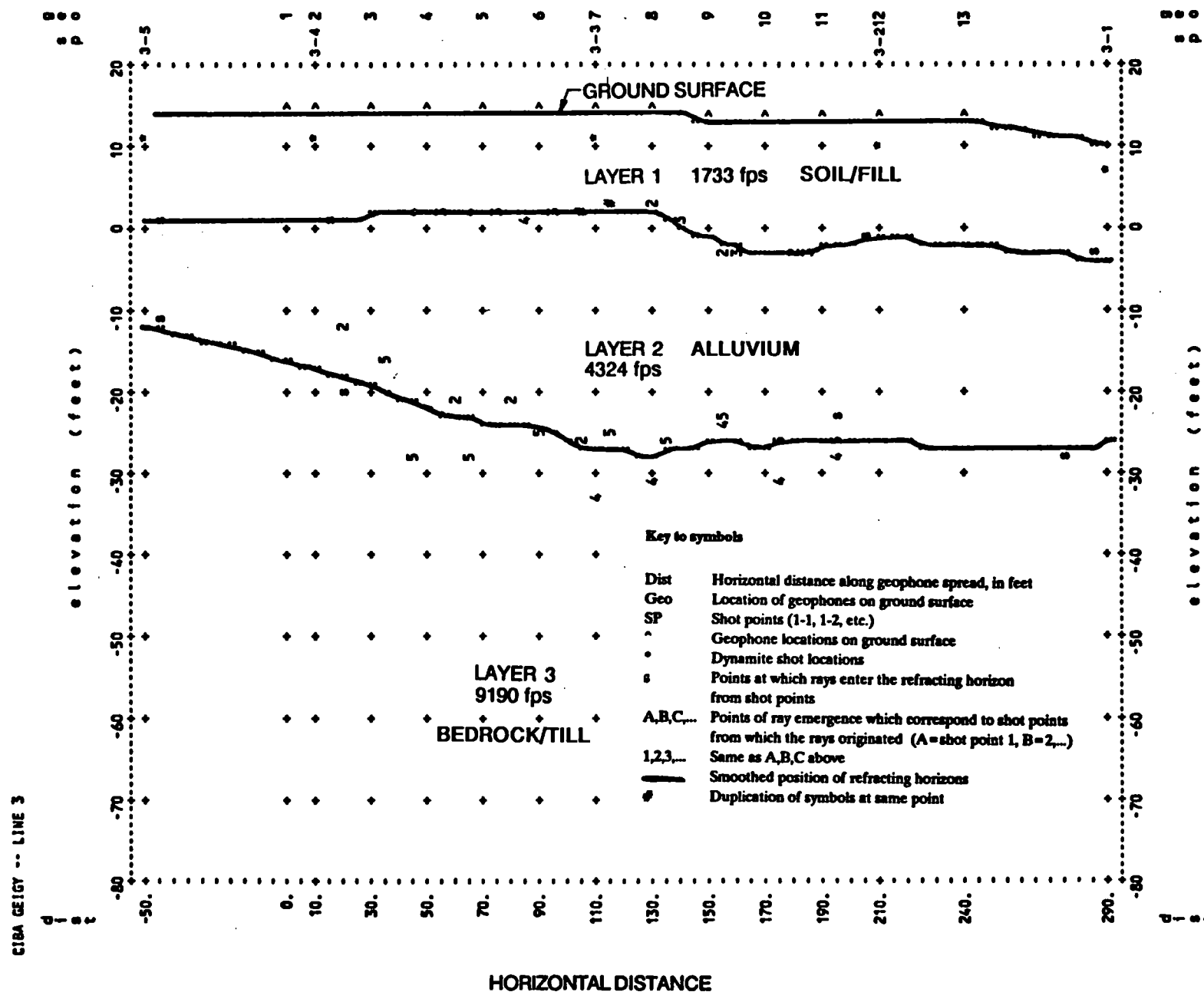


FIGURE 2-23

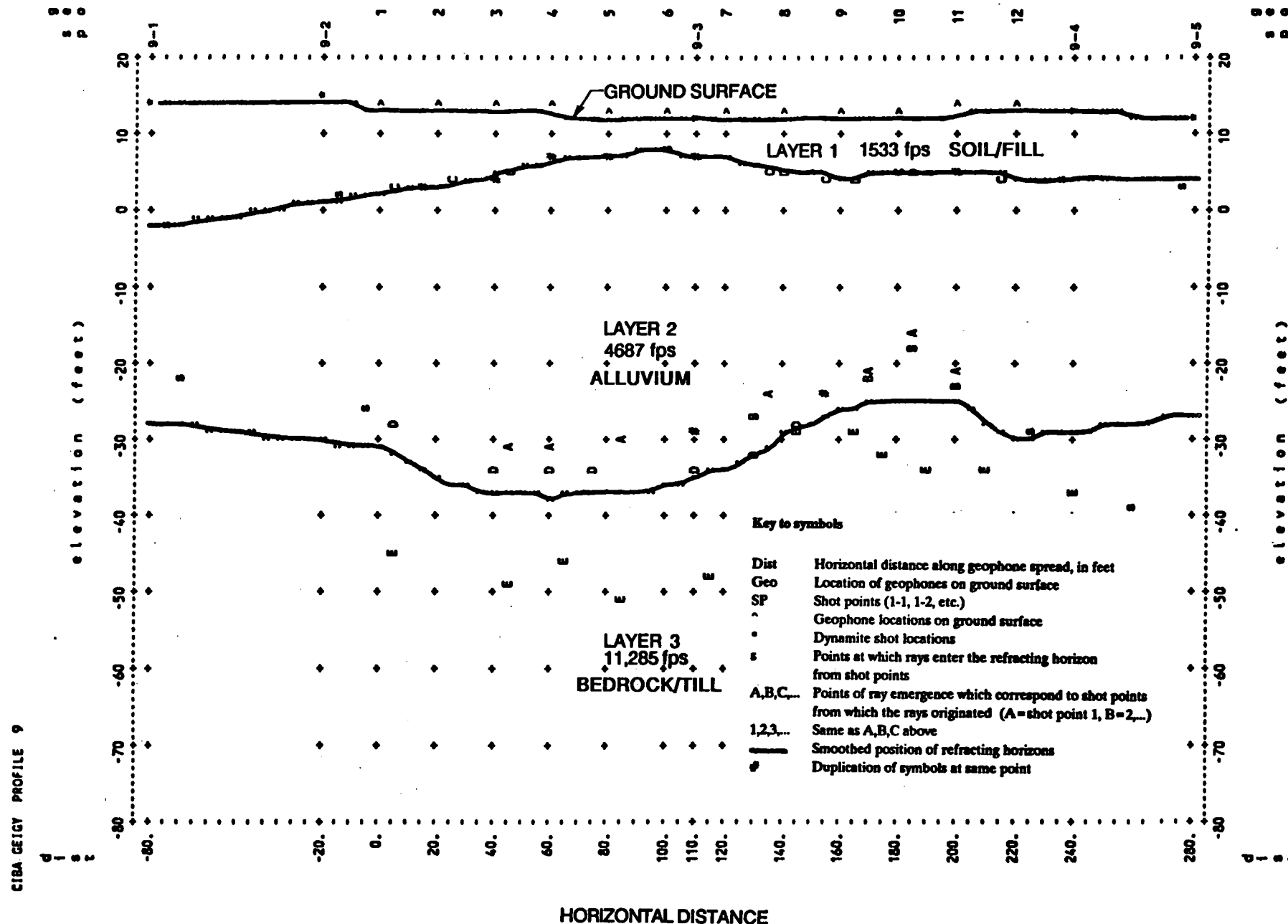


FIGURE 2-24